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ABSTRACT

Researchers have found that the elderly are as capable of learning motor skills as younger persons but perform better under some conditions than others. For example, the elderly learn and perform motor skills more efficiently when there is additional time to respond to stimulus. Tasks which are self-regulated rather than directed by an external source allow the older person additional time to monitor the accuracy of their response. This results in greater probability of an accurate response even at the expense of speed. This is a common trait of elders who feel that errors are more detrimental to quality performance than reduced speed. It is hoped that the use of cognitive strategies by older performers will enable them to be more efficient in feeling more comfortable and perform at maximal efficiency under a variety of environmental conditions. Examples of cognitive strategies which might be most compatible with meeting this objective include imagery, anticipation, self-verbalization, chunking, rhythm, focused attention, and pre-cueing. This paper includes a review of each of these cognitive operations and practical suggestions for using them in teaching the older adult learner. A 59-item reference list is appended. (Author/JD)

COGNITIVE STRATEGIES TO TEACH MOTOR SKILLS

TO ELDERLY LEARNERS IN NURSING HOMES

by

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Abstract

It has been determined by numerous researchers that learners have an active role in the processes of motor skill acquisition and retention. Persons engage in cognitive processing of information in the environment so they may anticipate the arrival of an object, the initiation of a stimulus, understand the demands of a task, or make accurate judgments and decisions prior to and during responses. It would be advantageous to the learner to make a conscious attempt to learn and use particular mental techniques that may expedite the processing of information and, consequently, facilitate the performance of motor skills. The advantages of using cognitive strategies are underscored by differences between younger and older persons in the learning and performance of motor skills. Researchers have found that the elderly are as capable of learning motor skills as younger persons but perform better under some conditions than others. For example, the elderly learn and perform motor skills more efficiently when there is additional time to respond to a stimulus. That is, tasks which are self-regulated rather than directed by an external source allow the older person additional time to monitor the accuracy of their response. This results in a greater probability of an accurate response even at the expense of speed. This is a common trait of elders who feel that errors are more detrimental to quality performance than reduced speed. It is hoped that the use of cognitive strategies by older performers will enable them to be more efficient in feeling more comfortable and perform at maximal efficiency under a variety of environmental conditions. Examples of cognitive strategies which might be most compatible with meeting this objective include imagery, anticipation, self-verbalization, chunking, rhythm, focused attention, and pre-cueing. This paper will include a review of each of these cognitive operations and practical suggestions for using them in teaching the older adult learner.

Persons of all ages play an active role in the mental processes associated with learning motor skills. The ability to acquire and retain motor skills has been shown to entail extensive use of cognitive operations (Anshel and Singer, 1980; Singer, 1980; and others). But only recently has there been more extensive investigation on the nature of these men..l operations and of the ways in which a person can use certain techniques - referred to as cognitive strategies - to enhance the learning and performing of skilled movements. It is hypothesized that the use of techniques that enhance motor skill acquisition and retention in the elderly can, potentially, retard the onset of retirement, result in the continuation of a productive professional career, and allow continued participation in recreational activites. In addition, it is possible that a decrease in physiological functions that normally accompany aging will be slowed (Spirduso, 1975).

Thus, the purposes of this paper are: (1) to examine the efficacy of using cognitive strategies to enhance motor skill learning; (2) to analyze briefly some of the differences between older and younger learners on learning and performing skilled movements; and (3) to suggest ways in which the elderly in nursing homes and elsewhere can learn and perform skills more effectively through the use of cognitive strategies.

A cognitive strategy is a psychological process imposed on or origiated by the learner that acts upon or manipulates incoming information to improve learning (Gagne, 1977). Strategies are skills employed by learners to regulate internal processes such as attention, thinking, learning, and remembering.

Strategies also signify operations that may be used to retrieve information from permanent (long-term) memory (LTM) (Rigney, 1978). For example, a strategy called imagery has been used to enhance the acquisition and performance of sports skills. In this technique, learners are asked to formulate and "hold" in their minds vivid visual image of a model demonstrating the to-be-performed skill. In recent years investigators have examined the effects of different learner strategies in psychomotor research.

Evidence of the improved performance of motor skills has been demonstrated with the use of strategies such as rhythm (Beisman, 1967; Mikol and Denny, 1955), rhythm and music (Anshel and Marisi, 1978), imagery (Housner and Hoffman, 1978 and Singer, Gerson, and Ridsdale, 1979, among many others), imagery with verbal labels (Zimmerman and Rosenthal, 1974), anticipation (Flowers, 1978), and chunking (Singer, Ridsdale, and Korienek, 1980). In addition, it has been clearly shown that the person's use of particular mental operations will result in significantly superior performance in the learning of verbal material (see O'Neil and Spielberger, 1978, for a review). Thus, it is apparent that the use of learner strategies, either alone or in combination, shows promise as a vehicle to affect the learning and performance outcomes in a positive manner.

Researchers have investigated the effect of a strategy referred to as <u>labeling</u> on motor short term memory. Using an arm-repositioning skill, subjects were asked to reproduce movements at locations designated with relevant or irrelevant labels. Groups consisted of relevant labels which described the criterion position, irrelevant labels in the form of low concrete nouns Shea (1977) or num, and a no-label control group. In both studies it was found that a 5-sec retention interval produced no differences in retention between the groups but that the relevant labeling group was significantly more accurate than the other groups after a 60-sec period prior to recall. Thus, it appears that learners need additional time to learn and implement a cognitive strategy - a finding that concurs with the findings of other studies in the use of imagery on learning.

As described earlier, imagery entails the use of vivid mental pictures to enhance the storage and retrieval of information. However, the process of encoding - placing information into the system to facilitate its storage into and subsequent retrieval from LTM - takes additional time (Gagne, 1977). This time-consuming process is especially true when using a mental imagery strategy because information is often encoded and stored in two forms: verbal (linguistic) and nonverbal (imaginal) (Paivio, 1971). Paivio describes this process as dual-coding and helps explain the successful use of imagery when "sufficient" inter-stimulus time intervals are available to learners.

For example, it was found in Hagenback's study on motor skill learning (mentioned earlier) that the use of imagery (subjects who imagined their limb to be the second hand on a clock) resulted in superior performance after a 60-sec but not a 5-sec time interval. The importance of giving ample opportunity to the learner to incorporate proper strategy usage is particularly important with children (Brown and Campione, 1977) and, as will be discussed later, with elderly learners. Other studies lend support to the use of cognitive strategies in learning motor skills.

Anshel and Singer (1980) examined the effectiveness of a combination of cognitive strategies - imagery, directed attention, rhythmic verbalization, and paraphrasing - on motor skill acquisition and long-term retention. Different skills of increasing complexity related to juggling three beanbags served as the criterion tasks. The directed attention strategy was used to assist learners in focusing on the most relevant components of the to-be-learned skill such as where to direct their visual attention. For the rhythmic verbalization strategy, learners were required to attach a label to each of a series of movements and overtly verbalize that label in rhythm with the movement during task performance. Paraphrasing, a technique in which learners communicate in their own words information derived from novel stimuli, was used when subjects were asked to teach a subskill to a partner. Imagery was described earlier.

The authors used the four strategies alternately and in combination. The results of the study indicated that subjects who used the strategies performed each of a series of juggling skills significantly better than non-users of strategies on both the acquisition and retention tests. Results of an earlier study by Anshel (1978) on the combined use of cognitive strategies were similar to Anshel and Singer.

It is apparent that cognitive strategies have been effectively employed to benefit significantly the learner's ability to learn and retain motor skills. In all of these studies, however, younger persons have served as subjects. There is an apparent dearth of research on the effects of cognitive strategies on the learning and performance of older individuals. Prior to examining the potential usefulness of mental techniques for elderly learners of motor skills, it is important to review the similarites and differences in performance capabilities as a function of aging. The information processing model will form the basis of these comparisons.

Information Processing

Essentially, three processes are affected by aging in motor skill acquisition, retention, and performance: (1) the perception that an event has occurred; (2) a <u>decision</u> in response to that event; and (3) the carrying out of an <u>action</u> based on the decision (Welford, 1977).

In the <u>perceptual mechanism</u>, data from the various modalities are identified, classified, and enhanced (supplemented) by data from LTM. It is here where input is given meaning (Singer, 1978). This process differs from that of detection in that through detection the organism merely acknowledges the existence of an object. Thus, upon completion of the perceptual mechanism, the system has analyzed relevant features of the input, consolidated these features into recognizable units, and applied meaning to the information to make an appropriate decision prior to computing a physical response.

The <u>decision mechanism</u> includes several steps: the retrieval of information from LTM, a comparison of this information with the learner's present knowledge of the environment, knowledge of the goal to be achieved, and the selection of an appropriate motor program - a predetermined set of neural commands which controls muscular activity (Klapp, 1976). The decision to respond is transferred to a centralized (effector) mechanism which programs a phased sequence of muscular actions for response execution.

The <u>action</u> is carried out through the transmission of a sequence of efferent neural commands to the chosen muscles in preparation for muscular contraction (Keele and Summers, 1976). Simultaneously, a replication of these commands, called the collary discharge, is emitted to a temporary (short-term) memory store for the sensory consequences of the upcoming movement (Singer, 1978). A search is then made of LTM to match the movement goal with the feedback. <u>This comparison process is central to the skill learning process</u> and serves as one important factor in the comparison of younger and older learners.

Differences Between Younger and Older Performers

It is apparent that aging is a factor in the learning and performance of many motor skills. However, some internal processes that produce performance outcomes are more affected by age than others. As indicated earlier, perceiving, decision-making, and physically responding to one or more stimuli are three of these primary processes.

Perception

The ability to perceive (give meaning to) stimuli changes with age. However, the degree to which older and younger performers differ is often a function of the type of task. Some tasks make significantly greater cognitive demands on the person than others.

Successful performance is often based on the ability to attend to a plethora of information and to register, store, and retrieve this data as quickly as possible to meet task demands and perform skills competently. There appears to be a deficit in each of these processes in the acquisition of both verbal material (Adamowicz, 1976) and motor skills (Cratty, 1975). It has been shown that the older learner: (1) needs additional time to store information in LTM (Hartley and Anderson, 1983; Welford, 1958, 1980), (2) exhibits a greater deficit in retention after a single trial, and needs more trials to reach a criterion of skill mastery (Cratty, 1975; Gilbert, 1941) as compared to younger persons. Older subjects take more time to perform on the first trial and improve more slowly on later trials than younger persons (Welford, 1980). However, when the elderly register and store information, it is well-remembered at a level similar to the younger person.

Anshel (1978), using a limb repositioning task and Wimer and Wigdor (1958) using a paired-associate word task, found that elders remembered what they had learned at similar levels to younger performers. The self-paced, i.e., "go at your own speed," nature of the tasks in both studies help explain these findings. Tasks which include a more rapid, externally-regulated presentation of stimuli as opposed to slower, self-regulated tasks, usually result in a performance decrement with age, a phenomenon referred to as a registration phase deficit (Adamowicz, 1976).

Making rapid and accurate decisions is a function of the rate at which incoming data can be matched with previously learned information and acquired skills (Schmidt, 1982). The speed of this process, experimentally regulated by the time a person is given to view a novel stimulus and the duration of the inter-stimulus interval, usually results in the older learner more negatively affected than the younger learner (Adamowicz, 1976; Welford, 1977). This has been labeled the retrieval deficit hypothesis (Craik, 1968).

Retrieval from LTM can take longer for the elderly under either of two conditions: (1) where the identification of incoming data involves an extensive search of memory (Riegal and Birren, 1965); or (2) where fine discriminations have to be made (Park, Puglisi and Lutz, 1982). For example, in a task in which subjects sorted cards according to letters printed on them, the performance of older subjects was more impaired than that of younger subjects by additional, irrelevant letters on the cards, i.e., when the number of stimuli requiring one response was increased (Rabbitt, 1965). In another study (Rabbitt, 1964), performance of elders was lower compared to younger performers with an increase in the number of different responses. One possible explanation for the retrieval deficit hypothesis is the effect of interference of past learning experiences on older, as opposed to younger, learners.

Typically, it is to the learner's benefit to associate new learning tasks with previously stored information (Gagne, 1977). In fact, one unique trait of an elderly learner that often causes superior performance as compared to children and young adults is the ability of older persons to use past experience and previously used techniques to master new skills. For example, in tasks for which accuracy and speed are required, elders are more cautious than younger people resulting in a slower rate of response. However, this results in a level of accuracy similar or better than younger persons (Welford, 1980). This "slow but sure" approach to motor tasks exhibited by older performers may well be due to their tendency to employ a variety of cognitive strategies which is frequently absent in young children (Brown and DeLoache, 1978), although both children and the elderly are capable of learning and using complex mental operations that improve memory and problem-solving when they are taught these skills (Brown and DeLoach, 1978; Denny and Denny, 1982). Thus, the expanded source of information available to the older person from permanent memory storage as compared to the relatively limited cognitive repertoire of the young child can be used by elders to approach and complete cognitive and motor tasks successfully. Inversely, however, improved performance outcomes due to previously learned skills can have a negaive impact. Researchers (Shooter, Schonfield, King and Welford, 1956) have measured decrements in performance due to the mastery of earlier tasks, a phenomenon referred to as proactive interference (Schmidt, 1982).

Probably the single major cause of [illegible] differences between the young and elderly are on <u>decision-making tasks</u> in which there is the tendency for elders to perform in a more cautious manner and be more concerned with accuracy than speed, especially on fast-paced motor tasks. Older people show a tendency to inspect incoming data for a longer time before making a decision (Botwinick, Brinley, and Robbin, 1958; Welford, 1978). For example, in one study (Craik, 1969), older subjects, gave a higher proportion of negative replies when deciding whether or not a faint tone had been sounded (tones for audibility had been equated for each subject before the study) as compared to younger subjects.

Even when the demands of making rapid decisions is significantly reduced as in a simple reaction time (RT) task, responses become slower as a function of age. Evidence for this is based on the effect of altering the foreperiod - the time interval between "ready" and the onset of a signal to "go" - on RT. Although persons of all ages are affected by very short (less than 1 second) or very long (more than 4 seconds) foreperiods, this affect is more pronounced on the elderly (Botwinick and Brinely, 1962). Welford (1978) suggests that people are less able than to prepare their responses before arrival of the signal to "go" with aging.

In summarizing use of the perceptual and decision-making mechanisms as a function of age, three points are salient: (1) The elderly need additional time to register, store, and retrieve information about skilled movements from LTM as compared to younger persons - a characteristic that is particularly salient when to-be-performed activities are relatively complex. (2) When subjects are able to learn and perform at their own rate (a self-paced task) as opposed to an externally-regulated pace, differences in performance as a fuction of age are significantly reduced. And (3) when the older person registers and stores new input successfully it is usually remembered.

Perhaps the task component that is most responsible for differences in performace between age groups is speed (Welford, 1977).

A multitude of studies in both the laboratory and industry have been completed in which the effect of aging on speed of movement was examined. Speed of work production has been shown to increase between the ages of 35 to 45 years and either remains constant (Breen and Spoaeth, 1960) or declines slowly (Clay, 1956). Laboratory results indicate greater decline in (slower) reaction time as compared to field data (see Welford, 1977, for a review). As Welford hypothesizes, this is probably due to the "survival of the fittese" (p. 487) in which the numbers employed in production jobs decline sharply from the late forties onward; "Those who leave tend to be less fit than those who remain." (p. 487). Perhaps two factors: (1) past experience which compensates for a loss in speed capacity in a field situation; and (2) the absence of using compensatory strategies in laboratory studies, particularly when measuring reaction and movement time, might help explain why reduced speed performance with aging is dependent not so much on the speed of movement execution but to the time necessary to plan and decide which actions to take.

The utilization of cognitive strategies, therefore, should be based on the following summation of the preceding material:

(1) The time needed to store new information in LTM increases with age.

(2) Elders take longer to inspect incoming data than younger persons. This is especially true for tasks in which the stimulus source is environmentally (externally) controlled and demanding of a rapid response. Under such conditions the time needed to make decisions is slower in older persons.

(3) Older performers are more cautious and show greater concern for accuracy than speed as compared to younger performers in making decisions.

(4) Relatively complex tasks which are characterized by a rapid series of signals and requiring fast responses result in performance deficits in the

elderly when compared to the younger learner. This is contrary to tasks in which the performer initiates the rate of stimulus-presentation and response and contains relatively longer inter-stimulus interval periods and longer stimulus viewing time. Under the latter conditions, the performance of older and younger persons are often similar.

(5) When the older performer has stored (acquired) newly learned information or motor skills, it is usually retained and performed at levels similar to younger persons.

(6) Previous experience on tasks similar to the new to-be-learned skill has been shown to affect the older learner more negatively than the younger learner - a result of proactive interference.

(7) The reduced speed of responding to a stimulus in elders is due to the required time to plan and decide on the response and not so much to a deficit in movement execution.

Suggested Use of Strategies

The primary objective of using cognitive strategies with older persons is to make novel stimuli more salient, meaningful, and familiar to the learner which, subsequently, will expedite the rate at which information is perceived, stored, and retrieved from LTM (decision-making) and put into action.

Perception

Often in performing an open skill in which the environment is relatively unstable and the demands of the task quickly vary, the process of stimulus perception can be very rapid. Where the demands of the task necessitate faster responses, it is suggested that strategies such as directed attention, anticipation, and labeling be used.

To use directed attention effectively, the learner must exclude from consideration inputs known in advance to be irrelevant and be able to identify relevant components (Singer, 1978). For example, when learning and performing a juggling skill, the person should keep his or her eyes at the optimal height of the tossed items (Carlo, 1974). The location of where the items are caught and their placement in the hands must be ignored.

The need to focus visually at the optimal height of tossed items is predicated on the use of location information as a reference point in central information processing, also referred to as cognitive mapping (Lindberg and Garling, 1982, among others). According to the authors, information about the location of reference points in the environment may be stored in permanent memory with the practice of a physical task. In order for this storage to occur: (1) the distance and direction of stimuli must b attended to; and (2) information about the location of the reference points (the height of tossed items in the present example of juggling) should be compared between actual and desirable performance outcomes and updated with practice. Thus, the acquisition of information about both relative locations of reference points and the locomotion path (of the juggled objects in flight, for example) underlie the importance of observing tossed items at their apex in flight and eliminating the need to focus on the catching component of the skill.

Anticipation appears to be a relevant cognitive strategy for the elderly. As previously discussed, the ability to respond to rapid and irregular signals deteriorates as a function of age. A combination of the decreased ability of elders to anticipate the onset of new stimuli and their propensity to monitor the previous response are purported to be two primary reasons for differences in performance due to age. Singer and Gerson (1979) have used the terms readiness strategy to describe techniques that better prepare the learner to receive stimuli. Anticipation is one such technique.

Singer and Gerson define an anticipation strategy as conscious energy directed toward potential task events based on prior experiences and probability. Anticipating the onset of a signal requires several mental events: (a) maintaining the proper arousal level; (b) a high degree of task familiarity; (c) possession of an internal model of the external world from which predictions about the future are made; and (d) the presence of a sensory set in which attention is directed toward the expected stimulus. In the proper use of anticipation, it is important that minimal attention be given to the previous response.

Finally, labeling may be used to attach verbal tags, which are personally meaningful to the learner, to form connections between skill (task) components. For example, retention might be improved if the learner associated either the source of a stimulus or the direction and target of a response with the face of a clock. The dials on a control panel might indicate three o'clock. Or performers may need to direct their response toward a location synonymous with twelve o'clock. This is exactly the strategy used by gunners on war ships when shooting at aircraft. In another example, more rapid and effective communication can occur using stimuli of different colors which can be labeled according to meaningfulness: blue lights might indicate height, i.e., the sky, in which the source of a simulus is above eye level; yellow lights indicate safety; and red lights represent danger, and so on.

Storage

Given the need to increase the amount of time for information storage in older learners, it would appear that the rate of presenting information or skills should be slowed. The learning process should not be hurried. Because making sense of environmental stimuli requires additional time with older learners, an instructional strategy of learning at the individual's own pace would be advantageous.

The use of self-contained learning modules, although not widely available in published form in the learning of sports skills, could be used for the purpose of self-paced storage (see Singer and Dick, 1980, on the construction of such modules). One study (Anshel and Singer, 1980) has indicated superior learning and performance outcomes due, in part, to the use of modular instruction as opposed to the traditional (group) teacher-centered approach in motor skill learning, particularly if cognitive strategies are applied.

Learner strategies that could be used to enhance storage, particularly on relatively rapid tasks, include: rehearsal, in which the learner identifies to-be-remembered information and covertly repeats it to oneself; chunking, where single "bits" of information or subskills are grouped in larger, more meaningful units which serves to reduce the amount of information that must be stored (Miller, 1956); and mental imagery, whereby the learner is required to create a vivid mental picture of the to-be-performed task or skill - a particularly effective strategy when the learner has enough time to construct the images (Winograd, Smith, and Simon, 1982).

Decision-making/Retrieval

The causes of longer times in decision-making and reaction tasks by elders are subject to much interpretation. Welford (1978) hypothesizes that the most likely explanation of slower reactions by older persons when offered very short foreperiods - particularly following a previous response - is "that the translation mechanism is busy monitoring the previous response or data from the warning so that data from the new signal are delayed" in the processing of information (p. 474).

There are several cognitive strategies that may be used by the older learner to work harmoniously with the habit of cautious and accurate responses, preferrably on a self-paced task. Three such strategies are paraphrasing (also referred to as self-verbalization) elaborate rehearsal, and elaboration.

Paraphrasing is a technique in which the learner transforms and interprets verbal material or motor skills into one's own words. Two conditions must exist for paraphrasing to occur. The two statements (of the teacher and the learner): (a) have no substantive words (nouns or verbs) in common; and (b) when they are equivalent in meaning (Anderson and Kulhavy, 1972). A paraphrase is related to the original sentence in meaning but unrelated as to the shape or sound of the words. Thus, paraphrasing presupposes comprehension of the original sentence.

Labouvie-Vief and Gonda (1976) used paraphrasing (referred to by the authors as a covert self-instructional or self-monitoring strategy) with elderly subjects on the training and transfer of verbal material. Subjects performed a problem-solving task while talking aloud to themselves, then while whispering, and finally, covertly without visible lip movements. They found significant increments in intellectual performance as compared to older subjects not using this technique. The authors also suggested, base on their review of the literature, that older persons are less effective in utilizing experimenter-imposed strategies but, rather, would perform better when generating their own strategies. The suggestion, therefore is to teach a series of cognitive strategies to learners based on the type of task to be performed (see Singer and Gerson, 1981, for the proper use of strategies by task classification) and allow learners to choose their own technique.

Elaborate rehearsal is referred to as a meaningful-connections strategy (Weinstein, 1978) which enhances the long-term retention of the information. The objective of using this technique is to enhance the meaningfulness of stimuli by forming associations, sentences, and images that organize information into patterns familiar to the learner. The repetition of these patterns facilitates their recall. This technique is particularly useful for more complex material or motor skills. Thus, instead of the mere repetition of information, the learner connects stimuli into organized units. This strategy is similar to another technique referred to as elaboration.

Similar to elaborate rehearsal, elaboration entails the construction of incoming data into organized and meaningful units, such as subskills of a higher-order complex skill. The difference between elaborate rehearsal and elaboration is that in the latter, the mental operations include greater use of creativity. Upon viewing and practicing the to-be-learned skill, the person might: (a) use elaboration to create a phrase or sentence to relate or connect to the skill or subskill; (b) reinterpret information into his or her own words; and/or (c) use mental images which connect verbal information to movements. Table 1 indicates the use of certain strategies based on the goal for its use such as making rapid decisions, permanent memory storage, or the short-term retention of information.

TABLE 1

Cognitive Process	Suggested Strategy
Short-Term Memory	Self-Talk
Long-Term Memory	Elaboration
Decision-Making	Focused Attention
	Categorization
	Anticipation

The following are behavioral examples in the proper use of cognitive strategies with elderly learners:

Imagery: "Relax, close your eyes, and think about successfully tying your shoelace."

Anticipation: "When observing a ball go to your right, predict its direction and, as soon as possible, move the paddle to the point of contact" (called a location cue).

Rhythm: "Attach a number or label to each dance step in rhythm with the music. Count '1 & 2 & 3 & 4' or 'step-together-step'."

Focused Attention: "Before hitting the golf (billiard) ball, concentrate on, and look at where you want the ball to go. Then, keep your eye on the ball when hitting it."

Chunking: "Take all the ingredients that require 1/4 teaspoon and mix them together."

Concluding Remarks

A plethora of comparative studies exist on the effects of aging on learning and retention although there are relatively fewer studies in the psychomotor area as compared to the verbal learning literature. The results of many of these studies indicate the limitations of older persons to perform similarly to younger subjects on a variety of cognitive and motor tasks. However, several issues need to be raised which challenge the efficacy of these conclusions.

Factors about the subjects in most studies which rarely have been taken into account, i.e., controlled, include: (1) education level and intelligence (whereas "younger" subjects are often college students, elders may not have completed grade school); (2) initial skill level and past experience in the experimental task (researchers rarely determine the learner's entering behavior); (3) health of subjects as influenced by physical fitness (Spirduso (1975) found that cardiovascular fitness eradicated age differences between elderly and younger performers on reaction time and movement time); and (4) motivation/arousal levels.

In addition, researchers have defined "old age" differently from study to study. Gerontologists divide old age into two groups: early old age, 65 to 74 years, and advanced old age, 75 years and above (Butler and Lewis, 1977). Considering that cognitive processes associated with learning, retention, and performance are different between ages 65 and 85 years, generalizing the results of studies to <u>all</u> older people is rarely valid (Atchley, 1977). Birren (1959) emphasizes the distinction between development and aging. "Aging is not simply negative growth" (p. 13). To Birren, the variables leading to the <u>development</u> of the organism do <u>not</u> apply in the aging process. Whereas form, size, and function of the child grow and change toward a final state, these qualites are both durable and persistent in the mature adult. Thus, it is the arrival of this "steady state" and not deterioration that best characterizes the older person. Although researchers should continue to study when and how performance limits are attained with age, the elderly should be perceived as capable and often consistent in their performance. Birren contends that "many differences between young and elderly persons are not due to aging but to differences arising from shifts in nutrition, ...education, public health, and attitudes" (p. 23).

It is clear that the elderly subjects in contemporary research are not likely to resemble older persons 30 to 50 years from now. There are currently 26.3 million Americans age 65 and over with a projection of over 35 million (about a 26% increase from the 1980 census) by the year 2000. They represent an extensive source of experience and knowledge. Certainly further research on the effects of aging on motor skill learning and performance to harbor this potentially valuable resource is warranted.

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